REMARKS

In the event that there are any questions relating to this amendment or to the application in general, it would be appreciated if the examiner would telephone the undersigned attorney concerning such questions so that the prosecution of this application may be expedited.

Please charge any shortage or credit any overpayment of fees to BLANK ROME LLP, Deposit Account No. 23-2185 (118097-00102). In the event that a petition for an extension of time is required to be submitted herewith and in the event that a separate petition does not accompany this response, applicant hereby petitions under 37 C.F.R. 1.136(a) for an extension of time for as many months as are required to render this submission timely.

Any fees due are authorized above.

Respectfully submitted,

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~~Method for detection~~Detection and improving visual attention deficit in humans ~~and a system for implementation of this method~~

~~By Oren Lamm~~

~~ABSTRACT~~

~~Reading disorders are diagnosed and remediated in a subject by measuring and improving his ability for temporal integration of partial signals appearing in decreasing frequencies. The moving signals are displayed on a visual display consisted of lights' columns. In order to be able to perceive the stimulus in whole, the subject should follow the signals appearing on the monitor by moving his eyes in the direction and timing of the lightened columns in smooth pursuit mode. At higher frequencies, the perception of the "whole" is natural since it based on a visible persistence time range. However, when presentation frequency is decreased below that range, visual attention becomes crucial for the perceiving of the presented stimulus. Subjects suffering from visual attention deficit (e.g. Dyslexics, ADHD children, Side neglect patients) fail in perceiving the stimuli at low frequencies, at which the control subjects are still capable of adequate identification of the stimuli.~~

~~A method for the treatment of visual attention deficit is suggested. The method is based on exposing a patient to a visual display, capable to generate various images suitable for use as stimuli and to run the stimuli with a required frequency in front of the patient. Following the training program, the patient's performance becomes considerably improved both on the display test and daily reading tasks.~~

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to detection and treatment of various temporal integration disorders, affecting certain daily tasks like reading accuracy. More particularly, the present invention ~~relates to methods and a system for estimating~~concerns estimation of visual attention as opposed to visible persistence~~. The inventor of the present invention has found by virtue of the present invention, a considerable~~ and improvement of visual attention ~~can be achieved. In particular, the present invention can be used for improving~~in general and reading ability of dyslexic and hyperactive children in particular.

2. Description of the Related Art

~~When a pattern of light falls on the retina, the image is processed within the retina by Ganglion cells, which send signals out of the eye to a relay nucleus in the thalamus of the brain. Cells of the thalamus in turn send signals to the visual cortex for further processing. There are two major types of retinal ganglion cells, which respectively contact~~

~~with two divisions of cells in the relay nucleus of the thalamus: the parvocellular division and the magnocellular division.~~

~~Cells in the parvocellular division have small receptive fields and are useful for visual tasks requiring a high degree of acuity. Cells in the magnocellular division, which are about ten times less numerous than those of the parvocellular division, have large receptive fields and are useful for visual tasks requiring a high degree of movement detection. Cells of the magnocellular division have coarse acuity and high contrast sensitivity.~~

~~In view of the above, the vision system of a human may be divided into two visual streams. The first stream is a magnocellular stream, which detects the movement of an object. This movement stream has a high sensitivity to a low contrast (for example, below 10%), to low luminance, to movement, and has low resolution.~~

~~The second steam is a parvocellular stream, which detects the color, shape, and texture of patterns. This second or acuity steam has low contrast sensitivity and high resolution. The acuity stream is most sensitive to contrasts above about 10%.~~

~~The parvocellular and magnocellular cells, either alone or in combination, provide the information used by many different visual cortical pathways (or "streams") which are specialized at performing different perceptual tasks. One such specialized pathway is a visual cortical area called Medial Temporal, or "MT," which is instrumental in the analysis of direction of motion. Most of the signals that drive neurons in the MT area derive from neurons in layer 4b of the primary visual cortex, which neurons in turn are primarily supplied by input from the magnocellular cells. (In primates, the primary visual cortex is the only cortical area that receives signals from the retina via neurons in the thalamic relay nucleus.) Direction selectivity is a fundamental characteristic of the magnocellular neurons and is mediated by cells in both layer 4b in the striate cortex and in the MT cortex. Certain aspects of magnocellular networks, such as direction discrimination and detecting of brief patterns, are still developing in all children with the age of 5 to 9 year, as compared to normal adults.~~

Some researches suggest that disorders of reading acquisition in children are related to magnocellular deficit or developmental impediment~~.~~, see for example US 6045515. This hypothesis is supported to some extent by findings that indicate that dyslexics have anomalies in their magnocellular networks, demonstrated by (1) higher contrast thresholds to detect brief patterns, (2) an impaired ability to discriminate both the direction and the velocity of moving patterns, and (3) unstable binocular control and depth localization when compared to normal individuals of the same age. ~~There exists substantial evidence that dyslexics have a disordered posterior parietal cortex and corpus callosum, having immature inhibitory networks that severely limit a child's ability to discriminate direction of movement and ability to read.~~ However it should be kept in

mind that most of the mentioned evidences were criticized on several grounds by other dyslexia researchers~~.~~ (for review see Hugban 2001).

~~Reading is the most important skill that is learned in the first and second grades. Yet there are no standardized ways to evaluate or to teach reading. A natural assumption is that reading relies on the higher resolution pattern system evaluated by measuring an observer's visual acuity and color discrimination ability. It is generally believed that movement discrimination is involved in reading solely as a means of directing eye movements, coordinating each saccade so that letter recognition can be conveyed by the portion of the vision system, which has a higher resolution. It is intriguing that difference between children with reading problems (e.g., those who are dyslexic) and children with normal reading ability were revealed only by tests of the cortical movement system. On the other hand, tests implementing the pattern system, such as visual acuity using long duration patterns, revealed no differences between children with normal reading and children with reading problems.~~ However, a recent study (Tallal & Merznich 1998) questions whether dyslexic children show a temporal processing deficit, and another study (DeLolo 1996) concludes that the contrast sensitivity functions (CSFs) of dyslexic children are unrelated to their reading ability.

~~However the~~The main claim of those researchers holding the view that dyslexia is related to magnocellular deficit is that dyslexics have longer ~~than~~then normal visible persistence while reading~~ due~~. This assumed to result from the lack of magnocellular inhibitory effect on parvocellular activation. According to this view, the saccadic eye movements between fixations activate, in normal readers, the magnocellular system, which, in turn, ~~inhibits~~suppresses the parvocellular activation initiated by the processing of the text seen at the former fixation.

Due to magnocellular deficit in dyslexics, this inhibitory process is ~~unreliable causing~~not reliably activated by the short saccades typical in text reading. Thus the transition from eye fixation to the next is accompanied by a masking effect, ~~were~~i.e. visual information gained in a former fixation masks the information gathered in the next or vice versa. ~~Thus the longer than normal persistence in dyslexics according to this view is due to a deficit in the system that is supposed to terminate it.~~

If this assumption was true then watching a text presented on a special display that gives an advantage to longer ~~than~~then normal visible persistence duration could be used to improve dyslexics reading.

Experiments conducted by the inventor with such a display clearly indicated that dyslexics exhibit inferior rather then superior reading of the display texts compared to normal readers. It was also verified that dyslexics were inferior ~~comparing~~compared to ~~the control group~~controls in recognition of any stimuli presented by this display. Further investigations ~~indicate~~indicated that dyslexics' difficulties are related to visual attention deficit that ~~impede~~impedes temporal integration of the visual partial signals when ~~those~~they are presented at low frequencies.

BRIEF SUMMARY OF THE INVENTION

In view of the foregoing drawbacks of the ~~existing~~ methods, known in the art, one of the objectives of the present invention is to provide ~~methods~~a method and ~~apparatus~~a system for ~~diagnosing~~diagnosis and ~~remediating~~remediation of reading disorders by respectively measuring and improving visual attention. ~~This is done by exposing~~Exposing the patients to slow smooth pursuit tracking of fragmented stimuli does this.

Dyslexic children who were treated by the method of the present invention significantly decreased their error reading rate after six to eight training hours and became significantly more efficient readers than children treated by other methods.

According to one aspect of the invention, a sequence of alphanumeric stimuli is displayed on a special display, capable to present the stimuli in a running mode. An example of a suitable display is the graphic display system described in the US patent 4162493. In this system~~,~~ the lights of an array are arranged in dot matrix and, when illuminated, are capable to produce the illusion of a moving sign ~~displaying~~, which is suitable for emulating letters, words, numbers, texts etc. This system has been initially designed for advertising and it employs the phenomenon of beta apparent motion to enable a moving image of a high resolution to be produced with the use of a small proportion for example 1/8, of the number of individual lights that would normally be considered necessary.

The lights are preferably arranged in consecutive columns being illuminated in turn in the direction of apparent movement of the image.

The display system enables ~~control~~controlling of time ~~gapes~~gaps between stimulus fragments with 1 millisecond precision. It has been empirically revealed that in a large subgroup of poor readers, being exposed to this display a visual attention deficit can be reliably established~~, which~~ and this deficit is closely related to their reading difficulties. It has been also found, that ~~this~~the visual attention deficit can be eliminated by further exposing the poor readers to the display according to the method of the present invention, which is described in more details later.

The principle of the present method will be referred-to further as a smooth pursuit tracking of stimuli fragments at slow tracking velocity. Smooth pursuit tracking as opposed to saccadic scanning implies in this context ~~means~~ that stimuli should be presented in such a manner that the visual illusion could be generated only if eye movements along the display are continuous and bear no fixations. Slow velocities in this context mean that the time intervals (gaps) between lighted columns ~~that~~ are longer than those, which are within the time range of visible persistence limit.

The present invention comprises the following main steps, ~~described below~~which are presented in ~~a form of~~an example below.

Step 1. Preliminary training of a patient (child or adult).

This step is carried out by exposing a ~~patient~~subject to a group of running stimuli consisting of ~~10-20~~15 alphanumeric signs and~~/or~~ words. The stimuli are displayed by the above mentioned graphic display system in a running mode with a velocity ~~matching the~~well within human visible persistence ~~limit of a normal person, who does not suffer from visual attention deficit~~range. In practice the required velocity at this step is established by setting a time gap of 80 milliseconds between ~~adjacent stimuli~~consecutive display columns. Usually, patients identify the displayed stimuli during the first or second run of the preliminary training step.

Step 2. ~~Diagnostics~~Diagnostic setup.

During this step the ~~patient~~tested person who passed the first step is exposed to ~~several~~nine word groups ~~of stimuli, consisting~~each consisted of ~~randomly presented~~six words~~. The groups consist of different words and they are not identical~~. The groups are displayed at~~, say,~~ three different velocities, which correspond to the time gaps of 80, 144 and 180 milliseconds. All in all 18 words are presented in each velocity of which six are

presented in all velocities. During each run ~~a~~the performance of the ~~patient~~subject is recorded in terms of ~~amount of~~ words correctly recognized ~~by him~~ from each group and at each velocity. On the basis of these results, the ~~patient~~subject is attributed either to ~~a person with normal reading ability, or to a person~~those who ~~suffers from~~suffer visual attention deficit or not.

Step 3. Treatment step.

During this step ~~the patient is~~those who suffer visual attention deficit are exposed to ~~those groups of stimuli, which he failed to recognize at the previous step at a certain velocity (failure velocity), but however successfully recognized them at the other (higher) velocity (successful velocity). The stimuli are displayed at this step~~alphanumeric symbols and words at an intermediate velocity, which lies between the failure velocity and ~~the~~his last successful velocity. The performance at the intermediate velocity is monitored and the intermediate velocity is varied according to the achieved results.

The present invention refers also to a system, which enables to carry out the above ~~method~~steps. The system comprises visual display connected to a computer, e.g. a PC. The display employed in the system is capable to generate visually recognizable stimuli and to present them in a running mode. The PC employed in the system is provided with ~~a~~ suitable software, which enables to control the display, to generate different stimuli, to vary the parameters of their display in the running mode, e.g. time gap between the stimuli, size of stimuli, etc.

The PC is also capable to accumulate, to store, to process the achieved results and to present them statistically, graphically or in any other desirable way, suitable for analysis and monitoring of the results.

BRIEF DESCRIPTION OF THE DRAWINGS

For better understanding of the invention and the way of how it ~~my~~may be carried out in practice, the invention will be now described with reference to the accompanying drawings in which:

Fig. 1 presents graphically ~~how~~ the ~~failure in recognizing of~~relation of display velocity to stimuli ~~during the treatment depends on the time gap~~recognition. The graph refers to a group of ~~control patients~~dyslexics and ~~to~~ a group of ~~those who suffer from visual attention deficit~~control subjects.

Figs.2-~~4 show~~3 shows various groups of stimuli, which are ~~presented~~used ~~during~~for carrying out the method of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The method of the invention has been devised on the basis of empirical work carried out by the Inventor.

The first investigation of the above-mentioned graphic display ~~system for treatment of visual attention deficit~~ was intended to ~~examine~~test the magnocellular hypothesis ~~that subjects of different dyslexia subtypes would perform differently when they are requested to recognize stimuli presented in a running mode by the above mentioned display~~. It was hypothesized that dyslexics suffering longer ~~than~~then normal visible persistence would better recognize simple alphanumeric stimuli than normal readers and other dyslexics given that stimuli are presented at low velocities preventing temporal integration on basis of normal visible persistence. However it was found that ~~visual-motor~~as much as 30% of the dyslexics were significantly inferior to ~~surface~~other dyslexics and normal readers in identifying the presented stimuli running at low velocities. ~~No differences were found between other dyslexics and control patients.~~

It was also found that reading training ~~in reading via~~with the aim of the display improves the ~~visual motor dyslexics'~~ performance of those who failed both in identification of stimuli at low velocities and in regular text reading - especially with respect to reading error rate. However the ~~three~~early experiments ~~performed~~ included a small number of subjects (at most 12 subjects in each experimental group) and did not allow a reliable estimation of reading impaired rate and the rate of such subjects that may benefit from a rehabilitation program intended to improve their attentive visual scanning.

Based on the knowledge and data gained from the above-mentioned experiments new large-scale trials were performed. These trials will be described in details since they are the main factual basis for my invention.

Experiment 1.

This experiment was intended to examine the distribution of poor readers, age matched ~~control patients~~controls and reading age ~~control patients~~controls according to their ~~identification~~ performance ~~in~~depending on different presentation velocities.

Method:

Subjects: ~~866 subjects~~551 good readers and 315 poor readers (age range 8 to 55) took part in this experiment. All subjects were native Hebrew ~~language~~ speakers that were educated in Israel with normal or corrected visual acuity.

The vocal reading fluency (reading speed and error rate) of all subjects was estimated by normative to ~~the~~ age/education level texts. ~~Poor~~The poor readers sample included only subjects that were 1.5 SD or below normal level on one measure and 1.0 SD or below that on the other. The control sample included only subjects that were at least 0.5 SD above the ~~normal~~ level on both measures.

Table 1 presents the distribution of subjects in both samples according to their age and gender.

Table 1

Subjects' distribution according to age and gender

Control group

Sums	Females	Males	Age Group	
8 - 12	117	71	188	
	13 - 17	104	64	168

	18 - 25	81	73	154
	26 - 55	26	15	41
Sums	551	223	328	

Poor readers

8 - 12	98	38	136
13 - 17	87	24	111
18 - 25	51	17	68
25 - 55	----	-----	-----
Sums	315	79	236

Procedure

Subjects' competence in identifying fragmented alphanumeric symbols and words in different time gaps between fragments were tested by exposing the subjects to the stimuli running over a graphic display similar to that described in Ross et al. 1976 invention and according to the following procedure:

a) Subjects were instructed to follow smoothly the lighted columns at the pace of the light traveling from one column to the next. Each subject was subjected to 12 to 20 training trails at fixed velocity. The time gap, corresponding to this running velocity was well within the time range of visible persistence (32 milliseconds gap between successive presentations of a fragment on adjacent columns).

In order to pass the test phase it was required to demonstrate 90% correct identifications within 3 presentation cycles of each stimulus.

All subjects completed the training phase successfully within 15 minutes.

After this step the further step has been carried out.

b) Each subject was exposed to stimuli presented at 4 different time gaps. The term time gap in this context means the time interval (milliseconds) between the lighting of two adjacent columns, which run over the display. ~~Proper tracking velocity is determined by this time gap.~~ The stimuli were presented as 4 groups, having different list of words. Each list included eighteen words, ~~consisting~~consisted of 3 to 5 letters. All words were the most common in written Hebrew for school children.

The basic time gaps for the different lists were 58, 116, 232 and 464 milliseconds. Each list was displayed at one of the above time gaps at random for each subject. Single presentation order was used, i.e. from the shortest time gap to the longest.

Subjects' performance was recorded. When the rate of correct responses for a given list in a given time gap did not exceed 28%, the time gap was shortened in half of the distance between the failure time gap and the preceding one (e.g. failure in 232 milliseconds time gap and above criterion performance in 116 milliseconds led to a test with 174 milliseconds time gape).

A list of 18 stimuli (consisted of words taken from the original four lists) was used for the test in the intermediate time gap. This procedure was repeated if failure was recorded at the intermediate gap, till the above criterion level performance (28% of correct identifications) was reached.

Performance higher than the criterion level at the intermediate gap led to the increase of the time gap in half the distance between the intermediate gap and the preceding one were failure was inspected. This procedure was repeated till the first below criterion performance was recorded again. Distribution of failure time gaps in both samples (controls of age group 26 - 55 are not included) is presented in Figure 1.

It is evident from Figure 1 that dyslexics fail at relatively shorter time gaps than the ~~patients~~subjects of the control group.

Table 2 presents the average number of correct responses in the longest time gap where the ~~patients's~~subject performance was above the criterion level and the average correct responses in the failure time gap in both samples.

Table 2

	Average correct responses in failure time gap	Average correct responses (last success)
X = 16.70		X = 2.78 (N=510) control
	SD = 1.64	SD = 0.89
X= 15.8	X = 2.38	(N=315) Dyslexics
	SD = 2.17	SD = 0.66

Table 2 indicates that the transition from success to failure is quite sharp and that within 20 to 30 ms time gap difference, performance may drop from 80~~-to-~~%-100 % correct responses to less than 20% correct responses.

Experiment 2.

This experiment was intended to examine the effect of the present treatment method for improvement of attentive scanning upon reading performance of dyslexics.

Method:

Sixty male dyslexics of the former experiment that failed in time gaps of 126 to 184 milliseconds were the subjects of this experiment. This time gap range was chosen since within it as much as 38% of dyslexics failed while only 5% of controls~~-did not demonstrate from 90 to 100 percent correct responses~~. The 60 subjects were sampled in triplets according to age and time gap failure. This enabled the division of the sample to three groups.

One group used as the experimentally treated group (treatment group). The second was given an alternative ~~treatment ('placebo')~~reading training and the third group did not get any treatment (no-treatment group).

The treatment group

Each of the 20 subjects of this group was engaged with eight one-hour treatment sessions. In the first session the subjects were exposed to words and texts presented at time gaps of their last success in experiment 1. Gaining 90% or more correct responses ~~with/without help~~ led to the increase of the time gap in quarter (e.g. subject that performed successfully in time gap of 117 milliseconds were presented with stimuli at 146 milliseconds). The same stimuli were presented at the increased time gap. If performance level did not dropped, a new set of stimuli was presented at the same time gap. Time gap was increased again if performance level for the new set was within criterion level. If, during the next 15 minutes of testing, the performance was still below the criterion level the time gap was decreased in half of the difference between the last success and the testing gaps. This process continued until the end of the treatment sessions.

~~Placebo~~Alternative reading training group

The 20 subjects of this group were given 8 thirty minutes treatment sessions of regular text reading. Each subject was presented with texts and words submitted to his yoked subject in the treatment group. The shorter treatment sessions in this group made more adequate the actual exposure time to texts as compared to the treatment group.

No treatment group

The subjects of this group were given the display test and the regular text reading tests but were not exposed to any treatment in between ~~by the experimenter~~Testing sessions.

On average, the time between initial and final testing in all groups was two and a half months.

Table 4 presents the vocal reading speed and error reading rate for standardized regular text before and after treatment.

Table 4

	Reading speed (words/min)		Error rate (%)	
	Before	After	Before	After
Group				
Treatment	X= 74.6 SD = 26.4	X = 87.3 SD = 19.9	X = 11.20 SD = 5.70	X = 4.10 SD = 2.80
~~Placebo~~ Alternative	X = 77.9 SD = 27.2	X = 83.3 SD = 28.6	X = 10.40 SD = 5.10	X = 8.80 SD= 5.2
No treatment	X = 72.8 SD = 23.7	X = 74.5 SD = 25.0	X = 13.2 SD= 6.6	X = 12.9 SD = 6.2

Since the texts given were standardized fluency tests, the subjects' performance could be evaluated according to their standard scores. Table 5 presents these data.

Table 5

Error rate		Reading speed	
Before	After	Before	After

Treatment	1.83 - 0.56	1.43 - 0.48	2.58 - 1.12	0.69 - 0.74
Placebo	1.69 - 0.63	1.60 - 0.72	2.32 - 1.75	2.06 - 1.64
No treatment	1.90 - 23.7	1.46 - 25.0	3.22 - 6.6	3.11 - 6.2

These data show the advantage of the display treatment over spontaneous improvement and routine reading training in the subjects. The main effect appears in reading error rate decrease. In order to evaluate the improvement consistency within subjects ~~of the experiments~~, the difference of the fluency measures were calculated for each subject in each group. In 19 out of 20 subjects of the treatment group, a decrease of error rate~~t~~ was recorded as compared to 8 and 10 cases in the other groups.

Table 6 presents the standard scores of the fluency measures for a novel text read only after the end of the treatment sessions.

Table 6

	Error Rate	Reading speed
Treatment	1.05 - 0.86	0.5 0.62
Placebo	1.23 - 1.0	1.94 1.43
No treatment	1.42 - 0.93	2.08 – 1.03

These data complies with the previous data as to the treatment effect on the reading error rate.

Clinical observations and post hoc analyses

Since most of the reading disabled participated in the above mentioned experiments were assessed by a cognitive battery intended for diagnosis of learning disabilities (Gordon et. al), it was of interest to examine weather their failure in the display test correlates with the performance on other cognitive tests.

In order to perform the correlations' inquiry, 116 files of subjects that failed in time gaps of 126 to 172 milliseconds were chosen (in that gap range only 2.9% of controls failed). The files of 116 matched reading disabled that performed normally on the display test were picked up too. Table 7 presents the distribution of the experimental group subjects according to age and gender.

Table 7

8 – 12	44	13	57
13 – 17	26	8	34
18 – 25	19	6	25
Totals	89	27	116

The performance of both groups on 27 different cognitive measures was examined. Four main tests were found to correlate with the display failure:

1. Point location in two-dimensional space (Gordon).
The average standard score of those failed in the display test was far below normal score (X= -1.6, SD = 1.19).
The matched reading disabled that performed normally on the display test was within the normal level (X= 0.56, SD = 1.38)
2. Digit – symbol test (Wecsler).
The average standard score of those failed in the display test was X= 7.64, SD= 2.26. The average standard score of matched reading disabled was X= 8.40, SD= 2.68).
3. ~~2.~~ Digit –Logograph test (Lamm).
The average standard score of those failed in the display test was X = 7.16, SD = 2.33. The matched reading disabled standard score was X= 10.34, SD = 3.06.
4. ~~3.~~ Specific graphic characteristics in writing to standard dictation (Lamm).
No standard scores are available for the evaluation of subjects' handwriting.
However it was clear that letters/words spacing and keeping parallel lines were much poorer in those subjects that failed in the display test ~~(see examples)~~.
The writing sheets of all subjects were evaluated by three independent observers, which were required to score each according to several criteria. It was found that the best differentiating criterion was letter and word spacing. Subjects that failed on the display test got average score of 3.9 (SD= 2.6) on an 1 to 9 scale. Other reading disabled got 7.2 (2.0). Comparable normal readers received an average score of 8.4 (1.8).
Some other tests differentiate the groups in the reverse direction. That is, the display failures ~~were~~ performed normally on these tests while the other reading disabled showed significantly inferior performance to norm level. Among these tests were free recall Word Dichotic Listening (Gordon) and the digit span (~~Wecsler) tests~~WISC-R / WAIS) test.

Background differences.

The main background difference between the two groups of poor readers are related to diagnosis of ADHD. In the display failures, 46 subjects were recommended to be treated by stimulants following medical assessment. Other 28 were labeled as ADHD by psychologists or other professionals in the fields of child development. The background data from other disabled readers indicate that only 7 subjects were actually recommended to be treated by stimulants and other 19 were labeled as ADHD following psychological or other developmental assessment.

Thus it seems that the graphic display is most useful treatment device in cases of Dyslexia and ADHD comorbidity.

On the basis of the above-mentioned experiments the present method has been developed and can be used in clinical settings.

It is disclosed below how the present method can be used for treatment of school children and adults.

1. Training step.

Subjects are presented with 15 initial training alphanumeric ~~stimuli~~signs and words, presented each in a time gap of 80 milliseconds~~.~~ These include all letter lines and angles used in the Hebrew alphabet. An example of the stimuli is shown in Fig.2a. Each stimulus is presented up to three times and subjects are instructed to name the presented stimulus. At this time gap all subjects identify all stimuli on the first to second presentation.

~~Following initial training, 54 words are presented in random order and in one out of three time gaps, which are 80, 144 and 180 milliseconds. The subjects' task is to name the word or it's letters.~~

2. Test step.

During this step the tested person who passed the first step is exposed to nine word groups each consisted of six words. These word groups are seen in Figs. 3a,b,c. The groups are displayed at three different velocities, which correspond to the time gaps of 80, 144 and 180 milliseconds. All in all 18 words are presented in each velocity of which six are presented in all velocities. During each run the performance of the subject is recorded in terms of words correctly recognized from each group and at each velocity.

The subject ~~is exposed to stimuli divided into groups as listed in Figs. 2b-4. Performance~~performance is evaluated on the basis of ~~correct identifications for each velocity / time gap~~correctly identified words. Prior data clearly indicate that normal readers can identify 16 to 18 stimuli out of the 18 presented stimuli in each time gap. This criterion, which is about 90% is the basis for subjects attribution either to those who suffer visual attention deficit or not. The common failure case takes place at the largest time gap. Most poor readers that fail ~~on the 180 milliseconds gap and~~in this velocity gain 0 to 5 correct responses~~. In severe cases this result is also recorded~~. Subjects that fail in the intermediate gap~~. Subjects that gain 6~~ (0 to ~~15~~14 correct responses~~for any of these~~) consistently demonstrate very poor performance on larger time gaps~~are scarce~~. No subject is expected to fail in the shortest time gap.

Thus, in most cases the results of this test are ~~a~~ clear cut and ~~detect~~ thus the test is highly reliable in detecting the appropriate candidates for subsequent treatment in order to improve the visual attention deficit.

The same procedure is also available for pre-school children but, instead of alphanumeric signs, namable object pictures are presented.

3. Treatment step.

The ~~same stimuli as in the previous step are used. The~~ treatment step is based on a systematic variation of time gaps ~~selection~~ according to subjects' former performance. Subjects that failed on the test in 180 milliseconds gap but performed reasonably on 144 milliseconds gap, (16 to 18 correct responses) are presented with letters, words and sentences in intermediate gap (162 milliseconds. for this example). Successful performance (90% correct) leads to the enlargement of the time gap to intermediate time between 162 to 180 milliseconds. If, on the other hand the subject fails on 162 milliseconds gap he gets the help of the experimenter for 15 minutes in identifying the presented stimuli. If the subject himself within this time limit does not reach the ~~identification~~criterion level, the time gap is shortened in half the gap between 162 to 144 milliseconds and the procedure is continued along the same lines. Improvement within 15 minutes ~~lead~~leads to the use of new group of stimuli, never presented before, at the same time gap. If adequate performance for that ~~list~~group is gained, the time gap is increased in half the time distance between 162 to 180 milliseconds. If 90% correct responses are not

recorded without assistance, the same ~~list~~group is used in a time gap, which is ~~shorter in quarter~~half of the distance between 144 and 162 milliseconds, i.e. ~~58~~ 158 milliseconds~~.~~ The enlargement of time gap in the treatment sessions always follows after successful reading of a new list never seen before by the subject. The same list is used in the initial presentation at the enlarged gap. Shorting of the time gaps is always combined with the use of the last ~~list~~group of stimuli presented at the larger time gap.

The training sessions are continued until the performance level of 90% is reached for 240 milliseconds gap or until the end of the eight one-hour sessions. Most subjects reach this criterion level within 5 to 8 sessions. Others reach 90% correct responses rate for gaps, which are between 200 to 235 milliseconds. Only few subjects (~~11~~17%) do not reach that level following eight sessions' training.

The same procedure can be also exploited for preschool children while specific object pictures instead of words are exposed on the visual display.

The present method can be implemented in any system, which comprises a graphic display~~, capable to generate~~ and a control means. The display should be suitable for emulating stimuli and ~~to present~~presenting them in a running mode ~~and a~~, while the control means~~, e.g. a PC,~~ should be suitable for varying the parameters of the graphic display, e.g. time gaps, sequence of display, etc. ~~and at the same time~~As an example of suitable ~~for recording~~control means one can mention a PC, which communicates with the display and is configured to control the parameters of display, to record data, associated with the patient's performance and ~~its statistical evaluation.~~to analyze recorded data statistically.

It should be appreciated that the present invention is not limited by the above-described embodiments and that one ordinarily skilled in the art can make changes and modifications without deviation from the scope of the invention as will be defined below in the appended claims.

For example instead of using graphic display, which is described above one can use other displays, e.g. screen of a TV set or even display, which can be worn on a patient's head as spectacles. Instead of using separate, dedicated display one can use control means, which has its own display, e.g. screen of a computer.

In the following claims the term *comprising* means "including but not limited to and the term *visual attention deficit* means deficit in processing fragmented visual stimuli as a whole due to short time gaps between presentations which are below the ability of human brain to detect such time intervals.

It should also be appreciated that features disclosed in the foregoing description, and/or in the foregoing drawings, and/or examples, and/or tables, and/or following claims both separately and in any combination thereof, are material for realizing the present invention in diverse forms thereof.

CLAIMS:

1. A method for detection and improving of visual attention ~~deficit~~ in ~~humans~~a patient, said method comprising:

    a) ~~a) Generating~~generating of at least one group of visually recognizable stimuli ~~b) Presenting the~~, said stimuli being presented by alphanumeric signs displayed in a running mode~~,~~ defined by a time gap between ~~adjacent~~consecutive stimuli

    b) ~~c) Exposing a~~exposing the patient to ~~at least one group of~~the stimuli

    c) ~~d) Determining~~determining the ability of the patient to recognize the stimuli

    d) ~~within the group and~~

    e) ~~e) Varying~~varying the time gap between the stimuli in accordance with the ~~ability of the~~ patient's ability to recognize the stimuli.

2. The method as defined in claim 1, in which said alphanumeric signs are emulated by virtue of lights of an array, in which said lights are arranged as a dot matrix.

3. The method as defined in claim 2, in which said lights are illuminated within the array to present a consequence of columns, said columns being fragments of stimuli, and said columns creating illusion of moving stimuli.

4. The method as defined in claim 1, in which said time gap is kept between 58 and 464 milliseconds.

5. The method as defined in claim 1, in which said alphanumeric signs are selected from the group consisting of letters and numbers.

6. The method as defined in claim 1, in which said stimuli are selected from the group consisting of letters, words, numbers and pictures.

7. The method as defined in claim 1, in which said patient is selected from the group consisting of children and adults. The method as defined in claim 1, said method comprising

a) a preliminary training step, in which the patient is exposed to the stimuli displayed at a time gap, which is set to match the within visual persistence frequency range limit of the human visual system of a normal person, who does not suffer from visual attention deficit

b) a diagnostic step, in which the patient is exposed to consecutive groups of stimuli, which are displayed at least at a first and at a second time gap, said second time gap being larger than the first time gap and said diagnostic step results in establishing whether the patient suffers from visual attention deficit

c) a treatment step, in which the patient suffering from visual attention deficit is exposed to those groups of stimuli, which were displayed at the diagnostic step, but the patient recognized only part of the stimuli within a group, wherein the patient is exposed to a group containing unrecognized stimuli, which is displayed at an intermediate time gap, said intermediate time gap lies between the first time gap and the second time gap.

8. The method as defined in claim 8, in which during the preliminary training step the patient is exposed to a single group of stimuli displayed at an invariant time gap and during the diagnostic step the patient is exposed to several groups of stimuli, each group being displayed at a different time gap.

9. The method as defined in claim 9, in which the single group displayed at the preliminary training step comprises 10-20 stimuli, which are letters, words and numbers and each group displayed at the diagnostic step comprises 6 stimuli, which are randomly selected words.

10. The method as defined in claim 8, in which the groups of stimuli displayed at the diagnostic step are not identical.

11. The method as defined in claim 8, in which during the diagnostic step the patient is exposed to 9 consecutive groups of stimuli, wherein each three groups are displayed at different time gaps.

12. The method as defined in claim 12, in which the consecutive groups are displayed at the time gap of 80, 144 and 180 milliseconds.

13. The method as defined in claim 8, in which establishing whether the patient suffers from visual attention deficit depends on the amount of stimuli correctly recognized by the patient at the diagnostic step.

14. The method as defined in claim 9, in which during the preliminary training step the single group of stimuli is displayed at least three times, each time at different time gap and during each time the amount of correctly recognized stimuli is recorded and the patient proceeds to the diagnostic step if he recognizes 90% of the stimuli.

15. The method as defined in claim 9, in which during the diagnostic step each group of stimuli is displayed at least three times, each time at different time gap and during each time the amount of correctly recognized stimuli is recorded.

16. The method as defined in claim 14, in which a patient is attributed as suffering from visual attention deficit when the amount of correctly recognized stimuli referring to the same group is less than 90%.

17. The method as defined in claim 13, in which during the treatment step the patient is exposed to consecutive groups of stimuli displayed at a first, second and third time gap, wherein the first time gap is shorter than the second time gap and the second time gap is shorter than the third time gap, wherein each time when the patient failed to recognize 90% of stimuli from a group displayed at the third time gap, but succeeded to recognize 90% of stimuli from a group displayed at the second time gap the patient is exposed to a group of stimuli displayed at an intermediate time gap, which lies between the third and the second time gap.

18. The method as defined in claim 18, in which each time when the patient failed to recognize 90% of stimuli from a group displayed at the intermediate time gap the patient is exposed to a group of stimuli displayed at a new time gap, which lies between the intermediate time gap and the second time gap and each time when the patient succeeded to recognize 90% of stimuli from a group displayed at the intermediate time gap the patient is exposed to a group of stimuli displayed at a new time gap, which lies between the intermediate time gap and the third time gap.

19. The method as defined in claim 19, in which the intermediate time gap is set to be an arithmetic average from the third time gap and the second time gap.

20. The method as defined in claim 19, in which the new time gap is set to be an arithmetic average from the intermediate time gap and the second time gap.

21. The method as defined in claim 19, in which the new time gap is set to be an arithmetic average from the intermediate time gap and the third time gap.

22. A system for detection and improving of visual attention in a patient, said system comprising:

   a) a display means capable to generate at least one group of visually recognizable stimuli, said stimuli being presented by alphanumeric signs displayed in a running mode with a time gap between consecutive stimuli, said display means is suitable to create illusion of alphanumeric signs linearly moving in one direction,

   b) a control means, communicating with the display means and suitable for modifying parameters of the display means as well as recording, storing and statistical evaluation of the patient's ability to recognize the displayed stimuli.

23. The system as defined in clam 23, in which said display means is capable to emulate the alphanumeric signs by virtue of lights of an array, in which said lights are arranged as a dot matrix.

24. The system as defined in claim 24, in which said lights are illuminated within the array to present a consequence of moving columns, said columns being fragments of stimuli.

25. The system as defined in claim 23, in which said control means is a PC and said display means is a graphic display with a settable time gap between the consecutive columns.

26. The system as defined in claim 26, in which the time gap is settable to be longer than the time range associated with visible persistence limit of a patient without visual attention deficit.

27. The system as defined in claim 26, in which said control means is capable to set the time gap between 80 and 180 milliseconds.

28. The system as defined in claim 23, in which said display means is a screen of a computer.

29. The system as defined in claim 23, in which said display means is a screen of TV set.

30. The system as defined claim 23, in which said display means is mountable on a patient's head to be in front of his eyes.

ABSTRACT

Method and system for detection and treatment of visual attention deficit is suggested. The method is based on exposing a patient to a visual display, capable to generate various images suitable for use as stimuli and to run the stimuli with a required frequency in front of the patient. Following the training program, the patient's performance becomes considerably improved both in terms of display test and in daily reading tasks.